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ABSTRACT

Because many students find the process of neural transmission difficult to understand, a classroom exercise was designed in which students bodily form themselves into the structure of a neuron and act out the process of neural transmission. The effectiveness of this exercise as a learning aid was tested by comparing two groups totalling 65 introductory-level psychology students. Both groups were taught by the same instructor. Following a lecture on neural transmission, the movement exercise group was compared to a simple review group on a 15-item quiz with the movement exercise group scoring significantly higher. A second experiment which attempted to replicate the results of the first did not show significant differences between experimental and control groups. However, it is suggested that movement-type exercises are worth developing to enhance both classroom enjoyment and learning, even though clear-cut advantages have not been proven. (Author/IS)

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A Classroom Movement Exercise for Teaching Neural Transmission

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Abstract

A classroom exercise is described in which students bodily form themselves into the structure of a neuron and act out the process of neural transmission. Following a lecture on neural transmission, the movement exercise group was compared to a simple review group on a 15-item quiz with the movement exercise group scoring significantly higher. It is suggested that movement-type exercises are worth developing to enhance both classroom enjoyment and learning.

A Classroom Movement Exercise for Teaching Neural Transmission

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One of the most basic and potentially confusing topics in a General or Introductory Psychology course concerns the process of neural transmission. With the plethora of new terms--dendrite, axon, synapse, etc.--which are suddenly introduced along with the complications involved in conveying the electrochemical transmission process, there is a tendency for students to end up with their cell bodies in revolt.

As a means of facilitating understanding of this process, as well as providing some relief from the tedium of lecture, I have designed a simple classroom exercise involving movement in which the students act out neural transmission. One of the factors which encouraged me to try a movement-type exercise in class was the work done by Jean Houston in her workshops (presented in Houston, 1980, 1982). Much of her work is based on the principle that education should be a psychophysical process, i.e., one that involves the totality of the mind/body system. Houston (1982) claims that learning is facilitated through stimulation of the motor cortex by the use of movement. Activation of the motor cortex is proposed to have a disinhibiting effect on thinking, feeling, and sensing. Houston also recommends involving as many other sense modalities as possible in the learning process.

The validity of these claims will have to awaite a thorough scientific investigation. However, I have used the following movement exercise as an aide in teaching neural transmission for several years and have received a

highly favorable response from students. The exercise can be done with as few as 14 students or with unlimited class sizes.

The Exercise.

I usually conduct the exercise after having introduced students to the terms identifying the parts and particulars of the neuron and after having described the process of neural transmission. Students are then asked to clear the desks away from the center of the room so that they can form themselves into a gigantic neuron. To do this, several students (three to n) are positioned shoulder to shoulder in a semi-circle facing out with their arms and fingers extended. They represent the cell body with its dendritic extensions. In a line extending from each of the open ends of the semi-circle (cell body) I align a row of students (two to n on each side) facing outward to represent the membrane wall of the axon. They are asked to extend their hands so that they are almost touching to signify the semi-permeable state of the axon membrane wall in a resting neuron. It can be pointed out that the spaces between their hands represent the nodes of Ranvier. Positioned outside the axon and between each of the "membrane wall students" are students (one to n) who represent positively charged sodium ions. Likewise, students (one to n) representing positively charged potassium ions are positioned inside the membrane wall facing each of the sodium ions, from across the node of Ranvier.

The terminal branches are formed by arranging the students (two to n) in one or several v-shaped extensions joined to the "axon wall students." One or more students can then be positioned behind the "terminal branch students" to represent neurotransmitters.

With the neuron now formed, students are instructed as to how to act out the process of neural firing. They can also be quizzed at this time by

having the different components raise their hands when asked to identify themselves. In preparation for axonal transmission the "membrane wall students" are given a "threshold number" that alerts them when to signify initiation of membrane permeability by dropping their hands. The "threshold number" is arrived at by having the cell body students count in sequence each time the instructor taps their hands (signifying dendritic excitation) until the identified threshold is reached. Upon hearing the "threshold number" called out by one of the "cell body students," the "membrane wall students" begin dropping their arms, beginning with those students closest to the cell body. As the "membrane wall students" drop their hands, the positively charged sodium ions rush into the axon while the potassium ions move to the outside. As soon as the transportation of ions takes place, the "ion students" are told to reverse the process and the "membrane wall students" are told to raise their arms again when the ions have returned to their original positions.

The students are told to conduct this process in sequence along the axon and as rapidly as possible. Once the signal has reached the terminal branch(es), the "neurotransmitter student(s)" are released into the synapse. In my demonstrations I have asked the "neurotransmitter students" to signify stimulation of the next neuron by running over to touch the wall or a desk before rushing back into the terminal branch. However, if a sufficient number of students were available, the demonstration could be extended by creating additional neurons to produce a sequence effect.

I usually require students to act out the exercise several times. Students invariably fail to perform the entire process correctly the first time--either the ions exchange out of sequence or the transmitter substances jump the gun, or everybody ends up running into each other, or a couple of people just stand there not knowing what to do. This is a good time to kid everyone about what

a mixed-up neuron they are representing and to instruct them as to how proper neural functioning should occur. After they have learned to act through the sequence satisfactorily, I ask them to run through it again until they can perform the entire process rapidly and accurately.

Once the students have learned their individual roles in the exercise, I ask them to attend to and get a feel for the process as a whole--to think of themselves as part of a single neural unit as they act out the process for the last time. The entire exercise, with several repetitions, usually takes about 20 minutes.

Evaluation Study.

I have used this exercise in General Psychology classes for the past several years with much success. Recently, I attempted to measure the effects of the exercise on learning. Since I was teaching two sections of General Psychology on MWF, I gave each class a lecture on the structure and processes of the neuron. In the next class period, one class (n=34) performed the above exercise prior to taking 15-item quiz on the parts and processes of the neuron. The quiz contained ten multiple-choice questions and asked students to label five parts of the neuron from a drawing on the board. The other class (n=31) was given a review of the lecture material before taking the same quiz. This review included a drawing on the board of a neuron, identical to the one I drew for the quiz, which I labeled and used to demonstrate neural transmission.

Results and Discussion.

A t test revealed that the movement exercise group scored significantly higher than the review group ($t = 1.94$, $df = 63$, $p < .05$, one-tailed test). I think it is worth noting that 59% of the movement exercise group scored 12 or better compared to only 35% of the review group.

This test of the effects of the movement exercise on learning is not designed to offer definitive proof of its superiority over a review method. Admittedly, this was not an ideally controlled study nor did it involve an elaborate design or a large number of subjects. However, the results of this simple experiment are encouraging and indicate that classroom exercises of this sort may have some worthwhile advantages over traditional instruction methods.

Even without statistical data to lend support, I would encourage use of movement exercises in class for a number of reasons. One is that much of the results have been apparent. In addition to adding a lively atmosphere to the classroom, which most students are quite appreciative of, the spontaneous comments and general favorable reaction were reasons enough to continue using the exercise.

As a result of conducting the experimental comparison reported above, another possible benefit occurred to me. I was struck by the fact that two students in the review class performed far below the others on the quiz and yet this lag effect was not observed in the movement exercise group. Could it be that requiring students to participate in an exercise of this sort facilitates learning in those not inclined to become involved in the learning process? Certainly, among the 34 students who did the movement exercise there were some who would have performed far below the others on a quiz if they had not been required to act out that which they were being asked to learn. Furthermore, one has to wonder to what extent kinesthetic and other systems involved in movement exercises contribute to learning in ways that traditional visual and auditory approaches do not. It seems that there may be a number of instances in which teaching through movement would have a heightened benefit for those who are not particularly suited for verbally oriented teaching methods.

While movement exercises seem to hold some promise for facilitating learning as well as for enhancing classroom enjoyment, an inspection of two leading publications of classroom activities for psychology (Benjamin & Lowman, 1981; Gardner, 1980) indicates that few content representational movement exercises have been developed. The possibilities for designing additional movement exercises to liven up classrooms, engage lagging students, and facilitate learning appears to be worth developing further.

An additional comparison of the effects on learning of a movement group (n=52) versus a review group (n=48) for this exercise failed to obtain statistical significance (t = .43, df = 98). One possible reason for this investigation's failure to obtain significance may have been due to the fact that the experimenter who conducted the lecture and the exercise was not the regular instructor for the course, whereas he was in the previous study. This investigation has not answered the question as to whether some students might be more responsive to learning through movement than others. That is, some students, who do not typically score well on a test following traditional instruction, may have scored better on a test following the movement exercise. It is also possible that an objective-type test is not the best means for measuring learning acquired through movement.

In conclusion, there is only weak support for the ability of a movement-type exercise, such as the one presented here, to facilitate learning as measured by an objective test. However, failure to demonstrate significant differences in learning aside, there is at least an equal degree of learning that occurs, and the ability to enact, through movement, what is being studied has a number of advantages beyond traditional instruction methods. Students are made to participate more actively in the learning process and to engage more sensory modalities. The major advantage appears to be that movement

exercises allow for a welcome break from the routine lecture format. In student evaluations of the course, the movement exercise on neural transmission is often reported to be one of the most worthwhile and enjoyable aspects of the course.

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